pages 235 and 236, after giving a description of the disease, he says:

This horrible disorder [the yaws] is contracted by inhabiting the same room with the patient, and by inoculation; this is effected by means of a small fly, from which every precaution is oftentimes of no avail. Great numbers of the insects of this species appear in the morning, but they are not so much seen when the sun is powerful. If one of them chances to settle upon the corner of the eye or mouth, or upon the most trifling scratch, it is enough to inoculate the *bobas*, if the insect comes from a person who labors under the disease.

It will be noted that, while Koster is not able to give the specific name of the fly, he definitely declares it to be a certain fly with well marked characters. It may be well to add that the disease called "bobas" throughout Brazil, is identified by Koster himself as identical with the "yaws" prevalent in Venezuela and the Guianas.

For the loan of the book from which this note is taken, I am indebted to the courtesy of Mr. E. C. Richardson, librarian of Princeton University.

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SPECIAL ARTICLES

A FURTHER STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE

THE advancement of science and the improvement of the conditions under which scientific work is done are of such vast importance for society that even the most modest attempt to introduce scientific method into the study of these conditions has some value. It is truly both exhilarating and appalling to face the opportunities and responsibilities of science and of scientific men. The applications of science have quadrupled the wealth which each individual produces and have doubled the length of human life. In many cases the gain has been greater than this. In transporting freight or printing a newspaper, the products of each man's labor have been multiplied a hundredfold; in equal measure the danger from smallpox, cholera and the plague has been diminished.

As intercommunication increases between the nations, bringing them all within the circle of our civilization, and as the total population of the earth grows, the number of scientific advances becomes continually larger and the value of each of ever greater magnitude. It is thus an economic law that the means of subsistence tend to increase more rapidly than the population.[1] When the applications of electricity increase the efficiency of each individual on the average by twenty per cent.—as may now be the case in civilized countries—the economic value would be in the neighborhood of twenty billion dollars a year. In comparison with a sum so inconceivable, the cost of science since the days of Faraday and Henry is altogether insignificant. In the United States at present there are scarcely more than a thousand men engaged in serious research work, and they do not on the average devote more than half their time to it. Throughout the world there may be seven to ten times as many. The investigations of these men may cost a total of $20,000,000 a year, perhaps one thousandth of what may be gained by the applications of electricity, or one hundredth of what is saved by the use of the phosphorus match.

But man does not live alone by the applications of electricity and the use of the phosphorus match. Science has given us a new heaven as well as a new earth, for it has checked not only poverty and disease, but also superstition, ignorance and unreason. It has done away with slavery and with the need of child labor; it has made excessive manual labor by women or by men unnecessary. By

[1] This inversion of the law of Malthus, to which the writer has called attention on several occasions (*e. g.*, SCIENCE, December 18, 1896) has recently been given a most interesting expression by Professor T. H. Norton (*The Popular Science Monthly*, September, 1910). Both the number and the value of scientific advances being directly proportional to the total population, the means of subsistence tend to increase as the square of the population.

giving the possibility of leisure and education to all it has made democracy possible. Finally science has not only given us leisure, but also the means to occupy that leisure in a worthy manner; its intellectual and emotional appeal is almost equal to the art and religion which were so much earlier in their origin.

Science has been more successful in the production of wealth than in its distribution and use, and it has been more effective in its control of the material world than of human conduct; but this is a natural result of necessary lines of development. The methods which have slowly extended from physics and chemistry to the more complicated phenomena of biology will give us sciences of psychology, sociology and anthropology and applications of these sciences commensurate with their dominant importance. Science has, indeed, already profoundly altered not only the material conditions of life but also social relations and mental contents and attitudes. The conditions of heredity and circumstance which determine the whole course of life are subject to its control. We need only to obtain the knowledge and to apply it. If an improvement of ten per cent. in the cereal crop will yield a billion dollars a year, in what terms of money should an increase of ten per cent. in the annual output of science be stated?

The application of scientific methods to the advancement of science is in one sense the beginning of science and in another one of its latest undertakings. We are at present almost wantonly ignorant and careless in regard to the conditions which favor or hinder scientific work. We do not know whether progress is in the main due to a large number of faithful workers or to the genius of a few. We do not know to what extent it may be possible to advance science by increasing the number of scientific positions or how far such an increase might be expected to add to the number of men of genius. We do not know to what extent increased salaries, better facilities and greater leisure would favor the quantity and quality of our work. We do not know to what extent non-rational sanctions, such as reputation, offices, titles, degrees, prizes, membership in exclusive societies and the like are effective. We do not know whether it is wise to combine teaching with research or applied with pure science. We do not know whether it is better for the professor and investigator to have a moderate salary, a life position and a pension, or to engage in severe competition for large prizes; whether obedience and discipline should be prescribed or the largest individual liberty allowed. We know but little as to the kind of education, methods of work and mode of life, which are most favorable to scientific productivity. In the face of endless problems of this character we are as empirical in our methods as the doctor of physic a hundred years ago or the agricultural laborer to-day. It is surely time for scientific men to apply scientific methods to determine the circumstances that promote or hinder the advancement of science. We should begin where and when we can; even though the results of the first efforts may appear somewhat trivial, we may proceed in the confident belief that in the end the advancement of science will become an applied science.

In a series of three articles published in the numbers of Science for November 23 and 30 and December 7, 1906, the writer described the methods which he used to select a group of a thousand leading American men of science, the application of these methods to the measurement of scientific merit, and the origin and distribution of the group. About seven years having elapsed since the selection of the group treated in these articles and a second edition of the "Biographical Directory of American Men of Science" being in preparation, it seemed desirable to repeat the process of determining the thousand leading scientific men in the United States. It is worth while to learn what changes have taken place in the composition of this group and in the distribution of the scientific men among various institutions and in different parts of the country. A list of scientific men as nearly

contemporary as might be was also wanted for some further studies of the conditions of heredity and environment which are favorable to scientific productivity.

The methods used to select the group of a thousand leading men of science were substantially the same as before and need not be redescribed in detail. The scientific men were distributed among twelve sciences as previously. It was intended that the number in each science should be proportional to the total number of investigators in that science, and it was as nearly so as is needful for the purpose in view. The distribution was as follows: Chemistry, 175; physics, 150; zoology, 150; botany, 100; geology, 100; mathematics, 80; pathology, 60; astronomy, 50; psychology, 50; physiology, 40; anatomy, 25; anthropology, 20.

In each science twice as many names were selected and written on slips with the addresses and positions. The ten men of science who stood at the head of the list in each science in the previous arrangement were asked to arrange the names in that science in the order of merit. The memorandum of instructions read: "It is obvious that such an order can be only approximate, and for the objects in view an approximation is all that is needed. The judgments are possible, because they are as a matter of fact made in elections to a society of limited membership, in filling chairs at a university, etc. By merit is understood contributions to the advancement of science, primarily by research, but teaching, administration, editing, the compilation of text-books, etc., should be considered. The different factors that make a man efficient in advancing science must be roughly balanced."

There were thus at hand in each science ten arrangements of those known to have done research work in the order of the value of their work, as estimated by those having expert knowledge. The ten positions assigned to each individual were then averaged, and the workers in each science were arranged in order. The lists for the twelve sciences were interpolated to form a combined list of a thousand scientific men. A second group in each science and a second group of a thousand scientific men were in like manner obtained. This was not done before, and the second thousand has less validity than the first thousand. It has, however, a certain interest for purposes of comparison.

The average of ten judgments is not necessarily more correct than any one of these judgments; the conditions are similar to observations in the exact sciences. One good observation may have more validity than the average of a number of observations made under less favorable conditions. But if ten scientific men concerning whose competence it is not possible to discriminate in advance make a judgment, we may take the average as the most probable value. If we had but a single judgment we should not know its validity, but with ten judgments the probable error can be calculated. These probable errors tell us not only the limits within which the place of an individual in the series is likely to be correct, but also measure the differences between the individuals.

This method of converting a qualitative series into a series of quantitative differences may be illustrated by the case in which it was used by the writer for the first time.[2] Some two hundred shades of gray were made, giving approximately equal differences in illumination between white and black. In such a series the grays toward the white end appear more alike than those toward the black end, and two adjacent grays are indistinguishable. Psychologically it is a qualitative series. If now the grays are arranged in the order of brightness a number of times by the same or different observers and the average position in the series of each gray is determined, the mean variation is inversely proportional to the psychological differences between the grays. There is thus determined the quantitative differences in the perception and its relation to the physical differences between the lights. The same methods have been used in the Co-

[2] "The Time of Perception as a Measure of Differences in Intensity," *Philos. Studien*, **19**: 63–68, 1902.

lumbia laboratory of psychology to measure the validity of beliefs, the beauty of pictures, differences in traits of character, literary skill and efficiency in various performances.

The method used enables us to measure not only differences in scientific merit, but also the accuracy of judgment of those who make the arrangements. It would be possible to determine whether those more eminent have the more accurate judgments, at what age the individuals are most competent and the like. As a matter of fact, the judgments in the present case were made by those most eminent in each science who were willing to undertake the task. Of the ten in each science who were placed at the head of the list in the previous study,[3] or 120 in all, 80 consented to undertake the arrangement, and of these 68 sent in valid lists. Others in the order of eminence were then asked until ten lists were obtained in each science. This study has thus only been made possible by the cooperation of those whose time is of much value. My personal obligations to them are very great.

The names of those selected for arrangement included all who were known to have done research work of any consequence, and those who arranged them were asked to add any who had been omitted. Some names deserving consideration were doubtless neglected and consequently would not find a place in the first or second thousands as ultimately selected. Each of those included in the first group is probably among the leading thousand scientific men in the United States, but there are a few others who belong to this group though not included. It might be a service to science to print the list of our thousand leading scientific men in the order of merit together with the probable error of each position, but it would require courage to do this, and perhaps it would not be possible to obtain the arrangement if it were to be made known. In the "Biographical Directory of American Men of Science" those are indicated by stars who belong either to the group as selected seven years ago or as selected now. Those who have won a place in the group can be identified by a comparison of the two editions of the book. Those who have lost their places in the group can not be known.

The arrangements of each of the two lists extended over a period of some months. The first list may be dated as approximately of January 1, 1903, and the second list as approximately of January 1, 1910. The distributions given in the previous paper refer approximately to January 1, 1906, the residences and positions used being those given in the first edition of the directory. For the present list, the residences and positions are those of January 1, 1910. It would be better if the arrangement of the first list and the distributions referred to the same date, but it was not possible to work up the data more promptly, as the writer was able to attend to the compilation of the directory and the statistics only during the summer months. In collecting and compiling the data he has had the very valuable assistance of Professor V. A. C. Henmon, of the University of Wisconsin, and of Mr. E. K. Strong, Jr., fellow in psychology in Columbia University.

Those included in the list of 1903 who died prior to 1910 number 58. It is a roll of honor which may be given here:

1903 (in part)	
Bolton, Henry Carrington	*Chemistry*
Rhoads, Edward	*Physics*
1904	
Beecher, Charles E.	*Geology*
Drown, Thomas Messenger	*Chemistry*
Hatcher, John Bell	*Geology*
Herrick, Clarence Luther	*Zoology*
Palmer, Arthur William	*Chemistry*
de Schweinitz, Emil Alexander	*Chemistry*
1905	
Brace, DeWitt Bristol	*Physics*
Eldridge, George Homans	*Geology*
Ellis, Job Bicknell	*Botany*
Ewell, Ervin E.	*Chemistry*

[3] Six were not asked owing to their illness or absence from the country. These conditions also account for a number of those who did not reply to the letter or did not consent to make the arrangement.

MATTHEWS, WASHINGTON	*Anthropology*
PACKARD, ALPHEUS SPRING	*Zoology*
PRESCOTT, ALBERT BENJAMIN	*Chemistry*
WARDER, ROBERT BOWNE	*Chemistry*
WOOD, EDWARD STICKNEY	*Chemistry*
1906	
LANGLEY, SAMUEL PIERPONT	*Physics*
MACCALLUM, JOHN BRUCE	*Anatomy*
MILLER, EDMUND HOWD	*Chemistry*
MORGAN, ANDREW PRICE	*Botany*
PAULMIER, FREDERICK CLARK	*Zoology*
PEIRCE, JAMES MILLS	*Mathematics*
PENFIELD, SAMUEL LEWIS	*Mineralogy*
RUSSELL, ISRAEL COOK	*Geology*
SHALER, NATHANIEL SOUTHGATE	*Geology*
1907	
ATWATER, WILBUR OLIN	*Chemistry*
CALDWELL, GEORGE CHAPMAN	*Chemistry*
CARROLL, JAMES	*Pathology*
CLARK, GAYLORD PARSONS	*Physiology*
GARDINER, EDWARD GARDINER	*Zoology*
GATSCHET, ALBERT SAMUEL	*Anthropology*
HEILPRIN, ANGELO	*Geology*
NEWELL, WILLIAM WELLS	*Anthropology*
REES, JOHN KROM	*Astronomy*
SAFFORD, JAMES MERRILL	*Geology*
1908	
ANTHONY, WILLIAM ARNOLD	*Physics*
ASHMEAD, WILLIAM HARRIS	*Zoology*
AUSTEN, PETER TOWNSEND	*Chemistry*
BROOKS, WILLIAM KEITH	*Zoology*
DAVENPORT, GEORGE EDWARD	*Botany*
GIBBS, OLIVER WOLCOTT	*Chemistry*
JOHNSON, SAMUEL WILLIAM	*Chemistry*
KELLERMAN, WILLIAM ASHBROOK	*Botany*
LEE, LESLIE ALEXANDER	*Zoology*
MASCHKE, HEINRICH	*Mathematics*
MASON, OTIS TUFTON	*Anthropology*
SNOW, FRANCIS HUNTINGTON	*Zoology*
UNDERWOOD, LUCIEN MARCUS	*Botany*
WHITEHEAD, CABELL	*Chemistry*
YOUNG, CHARLES AUGUSTUS	*Astronomy*
1909	
DUDLEY, CHARLES BENJAMIN	*Chemistry*
HARRIS, WILLIAM TORREY	*Psychology*
HOUGH, GEORGE WASHINGTON	*Astronomy*
NEWCOMB, SIMON	*Astronomy*
STEARNS, ROBERT EDWARDS CARTER	*Zoology*
STRINGHAM, WASHINGTON IRVING	*Mathematics*
TUFTS, FRANK LEO	*Physics*

The death rates for the six past years have been 6, 9, 9, 10, 15 and 7, on the average 9.3 per thousand. The rates for those under and over fifty, respectively, were approximately 3 and 21. The number of cases is too small for reliable data, but they show a youthful scientific population. In Great Britain there are annually elected into the Royal Society fifteen new fellows, and a membership of about 450 is maintained. The death rate is consequently over 30. It has been claimed that scientific men live longer than the average, and they probably do, but this can not be proved from the age at which they die, unless the age at which they become scientific men is known. If, however, we assume that scientific men live to the average age, we can from the age at which they die determine the age at which they become scientific men or reach a given degree of eminence.

In addition to those who died, there were removed from the thousand nine foreign men of science, who are no longer residents of the United States, and one other man whose address is unknown. There would thus be 68 vacancies on the list of 1910 to be filled by new men. In the order of the list, there is a probable error which increases from about 10 places at the top to about 100 places at the bottom. Consequently if the same scientific men were rearranged under the same conditions, each of those in the last hundred would be subject to a chance of one in four or more of being dropped from the list. In a general way 37 from the last hundred, 15 from the next to last, or ninth hundred, five from the eighth hundred and one from the seventh hundred—58 in all—might be expected to drop from the thousand as a result of rearrangement.

Apart from the 68 who died or were removed and the 58 changes due to a chance variation, there were 143 on the list of 1903 who failed to find a place on the list of 1910. These are the scientific men who did not maintain their positions in competition with their colleagues. There were 269 who attained a place on the list of 1910 for the first time. It

TABLE I. BIRTHPLACE AND RESIDENCE OF THOSE ADDED TO AND DROPPED FROM THE LIST

	Birthplace.							Residence.						
	Men Added.			Men Dropped.				Men Added.			Men Dropped.			
	New.	Old.	Total.	Out.	Dead.	Gone.	Total.	New.	Old.	Total.	Out.	Dead.	Gone.	Total.
North Atlantic.														
Maine	5	1	6	8	2	0	10	1	1	2	1	1	0	2
New Hampshire.	3	0	3	5	1	0	6	1	0	1	1	0	0	1
Vermont	2	1	3	3	1	0	4	0	0	0	1	0	0	1
Massachusetts	24	3	27	21	9	0	30	40	3	43	23	6	0	29
Rhode Island	3	1	4	0	1	0	1	2	1	3	1	2	0	3
Connecticut	6	0	6	5	2	0	7	14	2	16	4	4	0	8
New York	31	5	36	43	18	0	61	31	7	38	49	9	2	60
New Jersey	3	1	4	6	1	0	7	5	0	5	6	2	0	8
Pennsylvania	13	1	14	14	4	0	18	10	3	13	19	5	1	25
South Atlantic.														
Delaware	0	0	0	1	0	0	1	0	0	0	1	0	0	1
Maryland	2	0	2	4	0	0	4	11	2	13	6	2	0	8
Dist. of Col.	1	0	1	3	0	0	3	23	3	26	24	11	1	36
Virginia	7	0	7	5	1	0	6	0	0	0	1	0	0	1
West Virginia	2	0	2	0	0	0	0	1	0	1	0	0	0	0
North Carolina	0	0	0	0	1	0	1	3	0	3	1	0	0	1
South Carolina	3	0	3	1	0	0	1	0	0	0	0	0	0	0
Georgia	1	0	1	0	0	0	0	0	0	0	0	1	0	1
Florida	1	0	1	0	0	0	0	0	0	0	0	0	0	0
South Central.														
Kentucky	2	0	2	2	1	0	3	0	0	0	2	0	0	2
Tennessee	2	0	2	2	0	0	2	0	0	0	2	0	0	2
Alabama	1	1	2	0	0	0	0	0	0	0	0	0	0	0
Mississippi	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Louisiana	0	0	0	0	0	0	0	1	0	1	1	0	0	1
Texas	2	0	2	1	0	0	1	2	0	2	2	1	0	3
Oklahoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arkansas	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Central.														
Ohio	19	4	23	15	6	0	21	9	1	10	6	2	0	8
Indiana	11	1	12	3	0	0	3	5	0	5	6	0	0	6
Illinois	10	4	14	8	1	0	9	25	3	28	15	3	0	18
Michigan	17	0	17	8	1	0	9	5	0	5	2	2	3	7
Wisconsin	11	0	11	10	0	0	10	12	1	13	0	0	0	0
Minnesota	5	0	5	1	1	0	2	2	1	3	4	0	0	4
Iowa	8	1	9	3	0	0	3	1	0	1	3	0	0	3
Missouri	5	0	5	4	0	0	4	6	0	6	1	0	0	1
North Dakota	0	0	0	0	0	0	0	0	0	0	1	0	0	1
South Dakota	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Nebraska	1	0	1	1	0	0	1	4	0	4	3	1	0	4
Kansas	0	0	0	1	0	0	1	2	0	2	1	1	0	2
Western.														
Montana	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wyoming	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Colorado	0	0	0	1	0	0	1	2	0	2	1	0	0	1
New Mexico	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Arizona	0	0	0	0	0	0	0	1	0	1	1	0	0	1
Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nevada	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	1	0	1	0	0	0	0	1	0	1	0	0	0	
California	4	0	4	2	0	0	2	14	1	15	10	3	0	13
Alaska	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Hawaii	0	1	1	0	0	0	0	0	1	1	0	0	0	0
Philippines	1	0	1	0	0	0	0	2	0	2	0	0	0	0
Panama	0	0	0	0	0	0	0	0	1	1	0	0	0	0

	Birthplace.							Residence.						
	Men Added.			Men Dropped.				Men Added.			Men Dropped.			
	New.	Old.	Total.	Out.	Dead.	Gone.	Total.	New.	Old.	Total.	Out.	Dead.	Gone.	Total.
Canada	8	1	9	6	2	5	13	0	0	0	0	0	1	1
England	0	0	0	6	2	1	9	0	0	0	0	0	1	1
Scotland	3	1	4	2	0	1	3	0	0	0	0	0	0	0
Wales	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Ireland	1	0	1	0	1	0	1	0	0	0	0	0	0	0
Germany	5	1	6	1	1	0	2	0	0	0	1	0	0	1
Switzerland	0	0	0	0	1	1	2	1	0	1	0	0	1	1
Belgium	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Austria	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Russia	3	0	3	2	0	0	2	0	0	0	0	0	0	0
Sweden	1	1	2	0	0	0	0	0	0	0	0	0	0	0
Norway	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Japan	1	1	2	0	0	0	0	0	0	0	0	0	0	0
China	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Unknown	7	0	7	1	0	1	2	0	0	0	0	0	0	0
Total	238	31	269	201	58	10	269	238	31	269	201	58	10	269

seems best to remove from this group those who would probably have been given a place on the list of 1903, but were not considered at the time. They number 31, of whom only one is a foreigner who came to this country in the period of seven years.

There were 126 foreign-born men of science on the list of 1903. While the majority came to this country before attaining scientific reputation, a large number were called from Canada, Great Britain, Germany and other countries to fill positions in our universities, of whom seven were among our leading hundred men of science. The members of this group have added greatly to the scientific strength of the country, not only by the research that they have accomplished, but also because they have brought familiarity with the educational methods of other nations, and high ideals of scholarship and of the dignity of the career of the scientific man and university professor. It is surprising and truly most unfortunate that while nine leading foreign men of science have returned to their native countries during the past seven years, only one has come to America—one scientific man among seven million immigrants. There is no way by which the abundant wealth of the country could be used to greater advantage than by bringing to it men of promise and men of distinction.

We have then a group of 238 scientific men, who in the course of seven years have attained a place among the leading thousand, and a group of 201 who have lost their places. These two groups deserve careful consideration. Together with the other groups added to and taken from the list, they are distributed geographically in respect to birthplace and residence, as shown in Table I.

Massachusetts still retains its leadership in the production of scientific men, but it has lost ground in the course of the past seven years, while the north central states have gained. In the list of 1903, the birth rate of scientific men was at the rate per million population of about 50 in Maine, New Hampshire and Vermont, 109 in Massachusetts and 87 in Connecticut. If for purposes of comparison we increase the 238 new men to a thousand and again by 22.6 per cent. to allow for the increase in population of the country between 1860 and 1870, the corresponding figures (referred to the census of 1870) would be: Maine, New Hampshire and Vermont, about 40; Massachusetts 85, Connecticut 57. By the same method of comparison the figures have decreased in the central Atlantic states, as follows:

New York	47 to 36
New Jersey	42 to 17
Pennsylvania	23 to 19
Maryland	38 to 13

On the other hand, the north central states show an increase, the figures being:

Ohio	32 to 35
Indiana	21 to 34
Illinois	24 to 20
Michigan	36 to 74
Wisconsin	45 to 54
Minnesota	23 to 59
Iowa	30 to 34
Missouri	12 to 15

The cases are too few to give exact quantitative data, but a comparison of the north Atlantic and the north central states is significant. The former have lost seriously in their production of scientific men, while the latter have gained in every case except Illinois. Michigan rivals Massachusetts and surpasses every other state. New York on the list of 1903 surpassed every north central state, whereas the new men on the list of 1910 equal or exceed those from New York in six of the eight north central states. The big cities—New York, Philadelphia, Baltimore and Chicago—have lost ground. The birth rate per million inhabitants on the basis of 1,000 scientific men has fallen as follows:

New York	71 to 33
Philadelphia	49 to 23
Baltimore	94 to 19
Chicago	73 to 17

These cities, in spite of their vast wealth and great universities, and the fact that the ambitious and successful are drawn to them, are failing to produce scientific men. For the thousand of 1903, it was found that the urban birth rate was 50 and the rural birth rate 24. The 238 new men are too few to give reliable figures, but it seems that the cities are failing to produce scientific men, and presumably other men of intellectual performance, to an extent that is ominous.

Nebraska, Kansas and the states west to the Pacific have not improved, as the writer would have anticipated from the students in psychology who have worked with him. Probably the gain in the north central states is now extending westward and will show later. The southern states, though still lamentably deficient in their productivity of scientific men, have improved decidedly. They have produced 22 scientific men among the 238, as compared before with 48 among the 1,000.

Among the 238 men who have obtained a place on the list, 23 were born abroad, as compared with 126 among 1,000 on the list of 1903. The percentage from Canada and Germany is the same and it is larger from Russia. In the case of other countries the numbers are too small to be significant, except England, from which country there were 25 in the list of 1903 and not a single one among the new men on the list of 1910. As has been already noted, only one foreigner has been called to this country of such scientific standing that he would have clearly deserved a place on the list of 1903. Nearly all the foreign-born scientific men acquired their scientific reputation after coming to this country. Fifteen of the 23 were wholly or partly educated in the United States.

A comparison of the first and eighth columns in the table will show which states have retained fewer men than they have produced and which have drawn on other states. Thus the three rural New England states have produced 10 men and have retained but two, while Massachusetts has produced 24 and has at present 40. New York has exactly as many as it has produced, 31, though of course the individuals are not all the same. The District of Columbia must depend on other parts of the country for its scientific men; the number it has obtained, 23, is just the number born abroad, so the balance is even among the states. Illinois has called men from other states, Wisconsin and Missouri have maintained nearly an even balance, while the other central states have lost their men—Michigan 12 of 17, Ohio 10 of 19, Indiana 6 of 11 and Iowa 7 of 8. It seems a pity that these wealthy states can not retain the men they

produce or make an equal exchange with other states. The western states have tended to add to the number of men they have produced, thus California has produced 4 and acquired 10 more. The southern states have lost their men. Their increasing wealth has led to greater productivity, but they have not yet learned the importance of retaining and securing scientific men.

Reviewing the table with reference to those who have obtained a place on the list or have been dropped from it, we find that Massachusetts and Connecticut, which already had of all the states the largest percentages of scientific men in their populations—51 and 47 per million—now show the greatest gains. Nearly one fourth of the new men on the list reside in these two states, which have but 5 per cent. of the population of continental United States. At the same time, a comparatively small percentage of their scientific men have failed to maintain their places on the list, so that their net gains have been 22, or about 12 per cent. The figures refer to new men who have obtained places among the thousand in the course of the past seven years or to those who have lost their places on the list, and not to men who have maintained their places and have removed from one state to another. These two states have been fortunate in the possession or skilful in the selection of young men of ability; and credit should be given to their three great educational institutions—Harvard, the Massachusetts Institute and Yale. Another center of scientific activity and growth is found in the states of Illinois and Wisconsin, and is there also due to three leading universities. Illinois has 28 and Wisconsin 13 of the men added, while of those dropped from the list Illinois has 18 and Wisconsin none. The two states have a net gain of 23 men, or about 28 per cent. Missouri also shows a gain, while the other north central states remain about stationary.

New York, New Jersey and Pennsylvania have more men who have died or been crowded off the list of the first thousand scientific men than have attained places on it. The net loss has been 22 in New York, 3 in New Jersey and 12 in Pennsylvania. This is a sinister record for this center of vast wealth with its richly endowed universities. These three states can but ill bear comparison with the two progressive centers in the northeast and north central states.

The District of Columbia has 26 of the men added and 36 of the men dropped out. It has suffered more serious losses from death than any other region. Washington and the scientific bureaus under the government have lost somewhat. Large appropriations are made and useful work is done, but there seems to be a lack of men of genius and a paucity of important discovery. The Smithsonian Institution under Henry, Baird and Langley, the Geological Survey under Powell, the Naval Observatory when Newcomb and Hall were there, had promise and distinction which they lack to-day.

The western states have about maintained their creditable position, while the southern states have fallen still further behind. South Carolina, Georgia, Florida, Mississippi, Alabama, Louisiana, Tennessee and Kentucky had among them only 10 scientific men in the list of 1903. One man has been added and six lost. This record must be characterized as discreditable. The policy which leaves the south almost without scientific leaders is most foolish, even from the strictly utilitarian point of view. It appears that here too "he that hath, to him shall be given: and he that hath not, from him shall be taken even that which he hath."

The institutions with which two or more of the men added to the list are connected, together with those dropped, are given in Table II. As has been already indicated, Harvard, the Massachusetts Institute of Technology and Yale in New England, and Chicago, Illinois and Wisconsin in the north central region have been particularly fortunate in the possession of younger men who have acquired scientific reputation in the course of recent years. The same institutions have been equally happy in not having many men who

TABLE II. INSTITUTIONS WITH WHICH THE MEN ARE CONNECTED WHO HAVE BEEN ADDED AND DROPPED

Institution.	Men Added.			Men Dropped.			
	New.	Old.	Total.	Out.	Dead.	Gone.	Total.
Harvard	22	1	23	6	3	0	9
Chicago	13	1	14	3	1	0	4
Wisconsin	11	1	12	0	0	0	0
Yale	11	1	12	0	4	0	4
Johns Hopkins	9	1	10	5	1	0	6
Illinois	8	2	10	3	1	0	4
Mass. Inst.	8	1	9	2	0	0	2
Carnegie Inst.	8	0	8	1	0	0	1
Columbia	8	0	8	12	3	1	16
Stanford	6	1	7	1	0	0	1
Dept. of Agr.	6	0	6	11	0	0	11
Michigan	5	0	5	0	2	3	5
Cornell	5	0	5	6	1	0	7
Princeton	5	0	5	3	1	0	4
Geol. Survey	4	1	5	3	1	0	4
Bur. of Standards	4	0	4	0	0	0	0
California	4	0	4	4	2	0	6
Missouri	4	0	4	1	0	0	1
Nebraska	4	0	4	2	1	0	3
Bryn Mawr	3	1	4	0	0	1	1
Western Reserve	3	1	4	0	0	0	0
Amer. Museum,	3	0	3	1	0	0	1
N. Y. University	3	0	3	2	0	0	2
Pennsylvania	3	0	3	4	0	0	4
Minnesota	2	1	3	3	0	0	3
Brown	2	0	2	1	1	0	2
P. I. Bur. of Sci.	2	0	2	0	0	0	0
Catholic	2	0	2	1	0	0	1
Cincinnati	2	0	2	2	0	0	2
Goucher	2	0	2	0	0	0	0
Indiana	2	0	2	1	0	0	1
Kansas	2	0	2	0	1	0	1
North Carolina	2	0	2	0	0	0	0
Northwestern	2	0	2	3	1	0	4
Ohio	2	0	2	2	1	0	3
Rockefeller Inst.	2	0	2	0	0	0	0
Smithsonian Inst,	2	0	2	4	5	0	9
Texas	2	0	2	2	0	0	2
Washington (St. Louis)	2	0	2	0	0	0	0
Wellesley	2	0	2	1	0	0	1
Elsewhere	46	18	64	111	28	5	144
Total	238	31	269	201	58	10	269

have lost their positions on the thousand. This double success can not be attributed to chance, but must indicate skill in the selection of men or an environment favorable to good work. The Johns Hopkins and Stanford also stand well. Columbia, Cornell and California are the three universities which have lost the most. While Harvard and Yale have about three times as many men who have won a place as have lost it, Columbia has twice as many who have been dropped from the list as have been added to it. In the other universities and colleges the changes have been smaller, but they have considerable significance and deserve careful consideration. When we remember that seven adjacent states have not a single one of these men within their borders, it is not a small thing for institutions such as the University of North Carolina or Goucher College to have two of them. We may well ask why Pennsylvania should

TABLE III. THE INSTITUTIONS FROM WHICH MEN GRADUATED WHO WERE ADDED TO OR DROPPED FROM THE LIST

	Men Added.			Men Dropped.		
	A.B.	Ph.D.	Total.	A.B.	Ph.D.	Total.
Harvard	20	27	47	17	4	21
Chicago	5	27	32	0	1	1
Yale	15	13	28	5	2	7
Hopkins	5	22	27	2	17	19
Cornell	9	12	21	7	5	12
Columbia	4	14	18	8	8	16
Wisconsin	8	4	12	2	1	3
Michigan	8	2	10	6	0	6
Mass. Inst.	7	2	9	3	0	3
Minnesota	6	2	8	0	0	0
California	5	2	7	2	1	3
Stanford	3	4	7	0	0	0
Brown	5	1	6	2	1	3
Ohio State	6	0	6	0	1	1
Nebraska	5	0	5	3	1	4
Clark	0	4	4	0	2	2
Lehigh	4	0	4	1	0	1
Princeton	3	1	4	4	1	5
Amherst	3	0	3	6	1	7
Indiana	3	0	3	1	0	1
Pennsylvania	1	2	3	3	3	6
Syracuse	2	1	3	3	1	4
Texas	3	0	3	0	0	0
Elsewhere	70	7	77	79	12	91
Total	200	147	347	154	62	216
Leipzig	0	10	10	0	4	4
Göttingen	0	5	5	0	6	6
Berlin	0	3	3	0	3	3
Heidelberg	0	3	3	0	5	5
Edinburgh	2	1	3	1	2	3
Elsewhere	11	6	17	3	11	14
Total	13	28	41	4	31	35
Total	213	175	388	158	93	251
None	19	57	76	42	107	149
Unknown	6	6	12	1	1	2
Grand Total	238	238	476	201	201	402

compare so unfavorably with Yale, or Minnesota with Wisconsin.

Among the non-teaching institutions there is the same direct correlation between the men added and dropped. Institutions which have a good record in one case have it also in the other. It seems almost incredible that it should be possible to measure the efficiency with which an institution is conducted by such simple means, yet the differences can not be attributed to chance. The Carnegie Institution has the largest gains, though in view of its resources and exemption from inherited survivals, it does not compare favorably with some universities. The Bureau of Standards, the Philippine Islands Bureau of Science and the Rockefeller Institute have done well. The Department of Agriculture has lost about twice as many men as it has gained and the Smithsonian Institution with its dependent bureaus about four times as many.

Table III. gives the institutions at which three or more of the 238 scientific men who obtained a place on the list of 1910 received their degrees. The table also gives data for the 201 men who were dropped from the list. Of 232 of the new men whose education is known, all but 19 have the bachelor's degree and all but 57 the doctorate of philosophy or science. Some of those who did not receive the bachelor's degree were educated abroad and have its equivalent, and many of those not holding the doctorate of philosophy are doctors of medicine or have pursued university studies. Among the 1,000 on the list of 1903, 758 are known to have received the bachelor's degree and 544 the doctor's degree. The percentage of those holding the bachelor's degree has increased from 76 to 92, and of those holding the doctor's degree from 54 to 75. Our educational methods are thus becoming more completely standardized or conventionalized. The two men who stood first on the list of 1903, Simon Newcomb and William James, had neither the regular college nor the regular university education. Whether this was favorable or harmful to their genius is unknown; but it is probable that our present educational methods do not favor individuality and its early expression.

Harvard stands very clearly in the lead in its influence. Of the 232 men, 20 have received from it their first degree and 27 the doctorate of philosophy or science. Yale is the only university in the same class with Harvard as regards the bachelor's degree, and Chicago and the Johns Hopkins are the only ones as regards the doctor's degree. It is a curious fact that while Columbia and Yale have conferred in the past thirteen years about the same number of doctorates in the natural and exact sciences (189 and 179, respectively) as have Chicago, the Johns Hopkins and Harvard (245, 220 and 178, respectively), each can claim only about half as many of the new men who have obtained places among the thousand. Pennsylvania has the worst record in this respect, having conferred 133 doctorates and having only two doctors among the men added to the list. The 13 men who received the doctorate of philosophy from universities not given on the table received it from 11 different institutions, and the 81 bachelors not accounted for on the table received their degrees from no fewer than 70 colleges.

The colleges of the state universities have done better than those of the Atlantic seaboard. Thus Michigan and Wisconsin have each produced eight of the bachelors, while Princeton and Amherst have produced three, Dartmouth two and Williams one. In the list of 1903, Princeton and Amherst each had 23 bachelors among 758. The technical schools of the east have been more productive than the colleges; thus the Massachusetts Institute has seven and Lehigh four of the new men. Harvard, Yale and Cornell owe their good record to their scientific and technical courses. It is to be feared that the eastern college with "its frivolous amateurism and futile scholasticism" exerts influences actually prejudicial to the scientific career.

Leipzig, Berlin, Göttingen and Heidelberg are the four German universities which this time as last have conferred the largest number

of degrees. Among 175 of the newer men 21 have received the doctorate of philosophy from these four universities, whereas among 544 in the list of 1903, 112 received it from the same institutions. In about ten years the percentage of foreign degrees has decreased to nearly one half, and it is in course of further reduction. The number of foreign men of science educated abroad and coming to this country has, as shown above, also decreased. In so far as these changes are due to the improvement of our universities and to the increase in the number of native scientific men they are gratifying. None the less there is an aspect of the movement which is unpromising. It is not desirable that we should become more provincial than we are.

The education is known of 200 of the 201 men who dropped from the list. About 25 per cent. of these fall out through the probable error of arrangement, but in general they are those who have failed to maintain their scientific standing in competition with their colleagues. Twenty per cent. of those on the list of 1903 were dropped from it; of those on the list who hold the bachelor's degree 21 per cent. were dropped, and of those who hold the doctor's degree 17 per cent. were dropped. Those holding the doctor's degree thus have a small advantage; but this is only because the younger men are more likely to have the doctor's degree and at the same time more likely to maintain their positions.

Harvard had on the list of 1903, 106 of the bachelors and 57 of the doctors. It has now made a gain of three bachelors and 23 doctors. Chicago has made a notable gain, having added five of its bachelors and 27 of its doctors to the list and having lost but one doctor. Yale also has a good record, having increased its bachelors by 10 and its doctors by 11. The Johns Hopkins had 102 doctors on the previous list, nearly twice as many as Harvard and four times as many as Yale. It has lost 17 and added 22, and is thus still far in advance in the number of leading scientific men for whom it has provided higher education. Cornell has gained two bachelors and seven doctors. Columbia has added four bachelors and has lost twice as many; it has added 14 doctors and has lost eight; thus it has gained but two men on the list. The state universities, especially Wisconsin, have good records. Princeton, Amherst, Syracuse and Pennsylvania have lost more men than they have gained. The German universities have done well, having added more men than they have lost, in spite of the fact that the number of students studying in Germany has so greatly decreased. These figures are in part accidental, but they certainly throw a new light on the standards and efficiency of our universities.

TABLE IV. DISTRIBUTION OF THE MEN ADDED ACCORDING TO THEIR POSITIONS IN THE THOUSAND AND IN RELATION TO THEIR AGES

Science.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	No.	Per Cent.
Math.	0	3	1	1	3	2	3	2	2	4	21	*26.2*
Physics	0	2	1	3	3	7	8	5	8	7	44	*29.3*
Chem.	0	1	1	3	2	5	6	9	8	9	44	*25.1*
Astr.	0	0	0	1	0	1	2	1	0	2	7	*14.0*
Geol.	0	0	0	1	2	3	4	1	4	1	16	*16.0*
Bot.	0	0	3	2	0	2	5	4	6	1	23	*23.0*
Zool.	0	0	2	0	3	1	5	6	4	8	29	*19.3*
Physiol.	0	1	1	0	2	1	2	0	1	7	15	*37.5*
Anat.	0	0	0	1	0	1	0	0	0	4	6	*24.0*
Path.	0	0	1	1	3	3	4	3	2	0	17	*28.3*
Anth.	0	0	0	0	2	0	0	1	1	1	5	*25.0*
Psychol.	0	0	0	1	1	1	1	1	2	4	11	*22.0*
Number	**0**	**7**	**10**	**14**	**21**	**27**	**40**	**33**	**38**	**48**	**238**	*23.8*
25–29	0	0	0	1	1	1	1	1	0	1	6	
30–34	0	4	2	2	5	4	5	6	7	10	45	
35–39	0	1	4	7	10	13	15	11	14	17	92	
40–44	0	2	4	3	3	9	12	9	9	11	62	
45–49	0	0	0	0	1	0	3	3	6	6	19	
50–54	0	0	0	0	0	0	2	0	2	3	7	
Not known	0	0	0	1	1	0	2	3	0	0	7	
Number	**0**	**7**	**10**	**14**	**21**	**27**	**40**	**33**	**38**	**48**	**238**	

Table IV. shows the distribution of the 238 new men among the twelve sciences in relation to their positions in the thousand and the relation of their ages to the positions. The additions to each science are in the neighborhood of 25 per cent. and the departures from this average are within the limits of chance variation, but only 14 per cent. of the astronomers and 16 per cent. of the geol-

ogists are new, while 37.5 per cent. of the physiologists are new. Astronomy and geology are the sciences which were the most forward in the last generation, and this would lead us to expect a smaller number of changes apart from deaths.

None of the new men attains a place in the first hundred, seven reach the second hundred, ten the third and fourteen the fourth. Those who reach the highest positions are in the mathematical and exact sciences; men of exceptional ability advance more rapidly than in the natural and descriptive sciences.[4] Their success probably depends more on innate genius and less on persistent work. There are more "prodigies" in mathematics than in any other science, and they are more likely to maintain their promise. In this and in certain other respects mathematics is related to music and chess.

Nearly all the men obtain recognition between the ages of 30 and 45. They do their work earlier and have their ideas still earlier. Those who do not have their ideas before they are thirty are not likely to have them, and those who do not do good work under forty-five are not likely to do it. Not a single man over fifty-five has attained a place on the list, and only one man over forty-five has attained a place as high as the fifth hundred. The average age of those added to the thousand is 38.1 years and of those dropped from it 53.6 years. The corresponding median ages are 37.9 and 50.9 years. The writer knows a number of men who think that they have been hindered from doing research work by teaching or other distractions and intend to take up such work later, as when they retire on a pension, but they will almost inevitably fail.

While those added to the thousand are comparatively young, there are only six under thirty years of age, and only the same number in the complete list of the thousand leading scientific men. This is significant and disquieting. A man of genius is likely to do his work at an early age and to receive prompt recognition. Kelvin was appointed full professor at Glasgow at 22, Thomson at Cambridge at 26, Rutherford at McGill at 27. Men of science of this age and rank simply do not exist in America at the present time; nor is it likely that we are faring better in scholarship, in literature and in art. It will be shown further on that the increase in the number of scientific men of standing is only about one half so large as the increase in the population of the country.

It is sometimes urged that our men of genius are drawn into medicine, law and business owing to the large financial rewards of these pursuits. Any one acquainted personally with some of those who earn or get the largest money returns will probably doubt whether they are in fact men of genius superior to our scientific men. The hundred physicians who have the largest incomes selected from the hundred thousand physicians of the country, and the hundred multi-millionaires selected from the million men of business, do not obviously surpass in ability or character the hundred leading scientific men selected from five thousand.

It is indeed probable that the conditions existing in this country are paralleled in Great Britain, Germany and France. In no country does there seem to be a group of younger men of genius, ready to fill the places of the great men of the last generation. This holds not only for science but also for other forms of activity. There is no living peer of Lincoln, Bismarck or Cavour. An Academy of Letters is just now being planned in Great Britain, and its proposed membership is trivial compared with what it might have been in the middle of the Victorian era. It may be argued that we suffer from an illusion of perspective, that many a newspaper writer is the equal of the men of letters of the past, that our young doctors of philosophy would discover laws of motion if Newton had not anticipated them. But it would appear to

[4] In the complete list of the thousand the youngest man among the first 20, among the first 50 and among the first 100 is in each case a mathematician.

be a sufficient answer to write the names of Kipling, Barrie, Shaw, Wells and Chesterton besides the names of Carlyle, Ruskin, Mill, Spencer, Tennyson, Browning, George Eliot, Meredith, Dickens and Thackeray, or the names of the leading British, German or French scientific men now active with the corresponding list for forty years ago.

It is doubtless in part a question of relativity. By the nature of things there can only be a limited number of famous men, and it is not fair to compare a period of twenty years with the most productive period of all history. Both physical science and biological science have been rewritten within a generation, and it is possible that our scientific advance is more rapid to-day than it ever was before. None the less it is ominous for the future that there should be only six men of science of standing in the country who are under thirty years of age, and that the number of scientific men of standing should increase more slowly than the population.

There may be a racial senescence such as we seem to find in comparing the peoples of the Mediterranean with the Scandinavians and Sclavs, but it would be contrary to all our biological knowledge to suppose that the human stock could alter in a generation. In this period the number of individuals who have the education opening the gates to a scientific career has at least quadrupled. But eminent men are lacking; and this we must attribute to changes in the social environment rather than to deterioration of the stock.

The progress of science opposes a real barrier to its further advance. This is not because all the great discoveries have been made. The field of science is not a circumscribed territory which can be completely explored, but rather an area which the larger it becomes, the greater is the contact with the unknown and the more numerous and momentous are the problems pressing for solution. But as the known country becomes larger, each explorer has further to go before he reaches the undiscovered regions, and as he travels over the well-mapped land he loses the strength and vigor required for daring exploration. In plain English, the young man who must spend his early manhood in acquiring knowledge has passed the age at which he is most likely to have new ideas. The inherent difficulty we exaggerate by our educational methods. By our requirements for degrees, by our system of examinations, by our insistence on irrelevant information and ridicule of desirable ignorance and promising mistakes, we crowd on fat when the athlete should be relieved of every superfluous ounce. The doctor's thesis is supposed to be the first productive work; it is completed at the average age of twenty-eight years and is likely to be the working over of the old ideas of an old professor. In the meanwhile the creative instinct has atrophied.

Racial senescence, the lack of emotional stimuli and the accumulations of knowledge will probably set limits to the further advance of science. In the presence of racial senescence we should be entirely helpless, but it is possible that there is no such thing. Twenty years ago the Chinese were called a senile race, but such a statement could not be justified to-day. In a way our stock is as young as any, and the germ plasm may increase as much in complexity as it has since the amœba. Still a highly specialized organism is likely to become unplastic and extinct, and apart from physical exhaustion of the stock there is likely to be a social senescence. This is closely related to the lack of emotional stimuli. Great men and great achievements are likely to be associated with national excitement, with wars, revolutions, the rivalry or consolidation of states, the rise of democracy and the like. Such stirring events will probably disappear from the world civilization of the future, and it may be impossible to devise artificial stimuli adequate to arouse men from a safe and stupid existence. But exactly because within a century the great achievements of science may belong to the past, where the great creations in poetry, art and religion may perhaps now only be found, it is our business to do the best we can to assure the race of an adequate endowment policy.

It is probable that we do not attract to the scientific career the best possible men. There is perhaps no harm in our fellowships and underpaid assistantships, though a subsidized theological education seems to have drawn inferior men to the church. Those who carry on investigation for the benefit of society should be paid for their services by society, and the average doctor's thesis is worth at least $500. We must open the scientific career to many in order to catch in our net the few who count. But large prizes are lacking at both the beginning and the end of the scientific career. It is too closely bound up with college teaching and routine administration; its modest preferments are too often purchased by subservience rather than by independence, by neglect of research rather than by devotion to it. Permanent tenure of office so long as no offense is given, small advancements by the favor of a superior, long vacations and retirement on a pension, are not the rewards to attract the best men or to lead men to do their best work.

The apprentice system in which the beginner assists the expert is the best educational method, and if the right spirit exists on both sides it is the method most conducive to fruitful research. But the teaching of large classes of students having no real interest in the subject is not favorable to investigation. It not only takes the time and strength of the teacher, but to lecture continually "als dictirt euch der heilig' Geist" cultivates an attitude of superficial omniscience subversive of both the caution and the daring which should animate the investigator.

Three fourths of our leading scientific men hold teaching positions and earn their livings by teaching. The accomplishment of research work is usually a factor in the original appointment, and to this extent investigation is encouraged in the graduate schools of our universities. But the reward offered—usually an instructorship at about $1,000 a year—is small, and it is not adjusted to discriminate between men of possible genius and the commonplace squatter. The appointment once received, men are likely to advance by a kind of civil service routine, being on the average assistant professors with a salary of $1,800 at the age of 37 and full professors a little later at a little higher salary. The small advances in salary which may thereafter be given have but little connection with successful research. At the age of sixty-five the professor is no longer regarded as worth his salary, and is put aside on a pension at a time of life when men in other callings earn more than ever before. The only reward open to the professor is the presidency or some other executive position which takes him away from research work.

Money is certainly not the main thing in the world, but the desire for money is by no means so materialistic as is commonly assumed. The pursuit of wealth is an idealistic passion; it is rarely for the gratification of sensual pleasures and usually at the sacrifice of these. It is closely associated with the family—the creation of a home, the education of children, their establishment in life, the transmission of family sanctions and traditions. The pursuit of fame or reputation is usually far more selfish. It is further the case that we measure performance in terms of money. In each career those who do the best work are likely to receive the largest money rewards. These are consequently not only desirable as improving the conditions of living and of the family, in giving security for the future and in providing facilities for further work, but they are also ideal symbols of useful service. If the university president receives three times the salary of the professor and the professor's salary depends on the president's favor, the office of the professor is degraded. If the scientific man in the government service receives the salary of a clerk and is subject to the orders of a superior, he will be treated like a clerk and in the end will deserve no better treatment. As the writer has said:[5] "Professors and scholars are not sufficiently free or sufficiently well paid, so there is a

[5] "The Case of Harvard College," *The Popular Science Monthly*, **76**: 604–614, June, 1910.

lack of men who deserve to be highly rewarded, and we are in danger of sliding down the lines of a vicious spiral, until we reach the stage where the professor and his scholarship are not respected because they are not respectable."

University professors and scientific men doubtless belong to the privileged classes. If their salaries are too small in comparison with the incomes of the classes, they are ample in comparison with the wages of the masses. But the salaries and rewards are not adjusted to performance. In Germany the docents in the universities have had a meager support, but the professorship has been maintained as a high office. Promotion to it has not as a rule accrued through favor, through length of service, or even through personal presentability or skill in teaching, but as a reward for research work in which a man is judged by his peers. To this method of university administration must in large measure be attributed the primacy of Germany in research during the past century. In Great Britain and in France also the exceptional man has received exceptional honors.

In this democracy we face conditions into which the other nations are likely to follow us. Geheimrats, knights and academicians may become no more reputable than our LL.D's. As scientific men increase in numbers and their work becomes more highly specialized, it becomes more and more difficult to use fame and social distinction as rewards. The most plausible expedient would appear to be the establishment of research positions in our universities, in our endowed institutions and in the government service, better paid and more free than any now existing. By the will of Senator Vilas, the University of Wisconsin will have ten professorships with salaries of $10,000 and freedom from routine teaching. If each large university has such a scheme, the vacancies being filled by the professors and the position and salary being for life, a comparatively small expenditure would go far toward attracting exceptional men to the academic and scientific career and stimulating them to do exceptional work.

The difficulty confronting us is that our competitive system of payment does not apply to services rendered to society. The physician must promote health, the lawyer prevent litigation and the editor conserve decency at their own cost and to their own cost. The scientific man is not directly paid for his research work; he often has difficulty to find a charity that will publish it. The man of letters was formerly dependent on a patron, but thanks to the printing press, the increase of the reading public and the copyright laws, his condition has improved. The patent office has been of assistance to discovery; its scope should be extended to cover, for example, the production of new varieties of plants and animals, and, if possible, the production of new kinds of ideas. But methods should be devised by which scientific work will be rewarded in some direct proportion to its value to society—and this not in the interest of the investigator, but in the interest of society.

At the same time we must remember that human nature is extremely complicated and imperfectly understood. The fine flower of genius may wither in the sunshine more quickly than in the shade. Children are loved and cherished in direct proportion to the sacrifices made for them. There is a subtle distinction between play and work. It might happen that the joy of creation in art and science would be crushed by professionalism. The dominant motives of conduct vary from age to age, from land to land, from group to group, from individual to individual. But in spite of our ignorance of the causes of conduct we may have some confidence that among the restless nations of the west, poverty, celibacy, obedience and obscurity are exotic ideals which can not be used to make the scientific career attractive.

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(To be concluded)